supplying high-frequency power to plasma;

measuring a physical amount indicative of reflection or absorption state of the high-frequency power by plasma load; and

obtaining a frequency at which strong high-frequency power absorption is caused due to plasma density, i.e., a plasma absorption frequency based on the measurement result of the physical amount.

In the case of the plasma density information measuring method of the present invention, the high-frequency power is supplied to plasma, the physical amount indicative of reflection or absorption state of the high-frequency power by plasma load is measured (for example, the reflection amount of the high-frequency power or impedance value of the plasma load is measured). Based on the measured result of the physical amount, plasma absorption frequency at which high-frequency power resonant strong absorption is generated due to plasma density is obtained. If the high-frequency power resonant strong absorption is caused, since the physical amount indicative of reflection or absorption state of high-frequency power by plasma load is largely varied, plasma absorption frequency can easily be obtained. Since the obtained plasma absorption frequency has constant correlation with the plasma density, this is useful plasma density information. In the present invention, high-frequency power, i.e., high-frequency electromagnetic wave is supplied to plasma and thus, even if stains comprising insulative films are adhered to the antenna which supplies high-frequency power, there is little influence, and the plasma absorption frequency can be measured accurately.

In this point, the present invention is superior to the conventional Langmuir probe method. Because in this method, electric current flowing when ion in plasma reaches a surface of a metal probe is detected and therefore, if insulative film is adhered

to the metal probe, it is impossible to measure. Further, according to the present invention, since a hot filament is not used unlike the electron beam irradiation type plasma vibration probe method, there is no anxiety of breaking of filament, and it is possible to obtain the plasma density information over the long term.

In the method of the invention, it is preferable that the high-frequency power is supplied to plasma through a division wall. By interposing the dielectric division wall between the plasma side to be measured and the supplying side of the high-frequency power, a foreign object should not enter the plasma from the supplying side of the high-frequency power, and plasma can be maintained clean. Further, in the case of reactive plasma also, the high-frequency power supplying side is not damaged. Furthermore, even if stains such as insulative films are adhered to the surface of the dielectric division wall, there is no change in the measuring system, it is possible to obtain the plasma density information for longer time.

In the present invention, for example, the physical amount indicative of reflection or absorption state of the high-frequency power by plasma load is measured by measuring an electric current amount of a high-frequency amplifier for supplying high-frequency power. Through the high-frequency amplifier for supplying high-frequency power, electric current corresponding to a degree of reflection or absorption of the high-frequency power by the plasma load flows. Therefore, it is possible to easily measure the physical amount indicative of reflection or absorption state of the high-frequency power by measuring this electric current.

In the present invention, for example, the reflection amount of high-frequency power is detected while sweeping high-frequency power frequency, and the plasma absorption frequency is obtained based on relationship between sweep-frequency and a detected result of the reflection amount of high-frequency power. That is, it is possible

to easily obtain a frequency at which the reflection amount of the high-frequency power is largely reduced, as a frequency at which the high-frequency power resonant strong absorption is caused due to the plasma density, i.e., as a plasma absorption frequency.

In the present invention, a plasma surface wave resonance frequency is obtained as the plasma absorption frequency for example. The surface wave resonance frequency f is correctly corresponds to the electron density n_e in plasma.

In the present invention, electron density in plasma to be measured is calculated in accordance with the obtained plasma surface wave resonance frequency. That is, the electron density n_e in plasma is calculated in accordance with the surface wave resonance frequency $f=\omega/2\pi$ (wherein ω is surface wave resonance frequency). The electron density n_e is substantially equivalent to the plasma density. The electron density n_e can easily be calculated in accordance with the following equation (1):

$$n_e = \varepsilon_o \cdot m_e \cdot \omega_p / e^2 \qquad \ldots (1)$$

wherein ω_p: electron plasma angle frequency

$$[\omega_p = \omega \times \sqrt{(1+\varepsilon)}]$$

ε : dielectric constant of dielectric division wall, ε_o: vacuum dielectric constant

m_e: electron mass, e: electron amount

In the present invention, for example, Tonks-Dattner resonance frequency is obtained as the plasma absorption frequency. If the high-frequency power is radiated to the plasma, a plurality of absorption spectrum is observed in addition to the surface wave resonance. It is considered that this corresponds to so-called Tonks-Dattner resonance. That is, when electromagnetic wave is radiated from outside of cylindrical plasma and power absorbed by the plasma is measured, strong absorption is caused at plurality of frequencies around the electron plasma angle frequency ω_p. This